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Ito et al.

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(54) **VALVE DEVICE FOR COMPRESSOR**

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(73) Assignee: **SANDEN CORPORATION**, Gunma (JP)

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F16K 17/00	(2006.01)
F16K 21/04	(2006.01)
F04B 39/10	(2006.01)
F04B 53/10	(2006.01)

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CPC ***F04B 39/1086*** (2013.01); ***F04B 39/10*** (2013.01); ***F04B 39/1073*** (2013.01); ***F04B 53/105*** (2013.01); ***F04B 53/1087*** (2013.01); *Y10T 137/7891* (2015.04)

(58) **Field of Classification Search**

CPC .. F04B 39/1073; F04B 39/1066; F04B 39/10; F04B 53/105; F04B 53/1087; F04B 39/108; F16K 15/14; F16K 15/144; F16K 15/16; F04C 29/128

USPC 137/512.1, 512.15, 512.4, 527, 137/854–858, 843, 852; 251/332, 333, 334, 251/359

See application file for complete search history.

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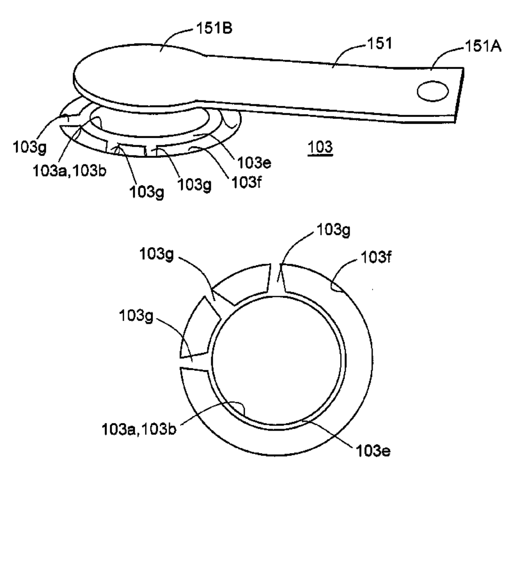
(57) **ABSTRACT**

A valve device for a compressor is improved to suppress noise and a decrease in compressor efficiency caused by pressure pulsations, and also to prevent degradation in compressor performance by ensuring durability. In a valve device of a reed valve structure including: a valve hole **103***a* or **103***b* formed in a valve plate **103**; a valve seat **103***e* formed in an outer peripheral portion of the valve hole so as to protrude in a boss shape to a groove **103***f* formed around an outside thereof; and a valve body **151** having a proximal end **151**A connected to the valve plate and a distal end **151**B allowed to freely come into and out of contact with a seat surface of the valve seat, a plurality of ribs **103***g* extend radially from a peripheral wall of the valve seat to an outer peripheral wall of the groove.

5 Claims, 10 Drawing Sheets



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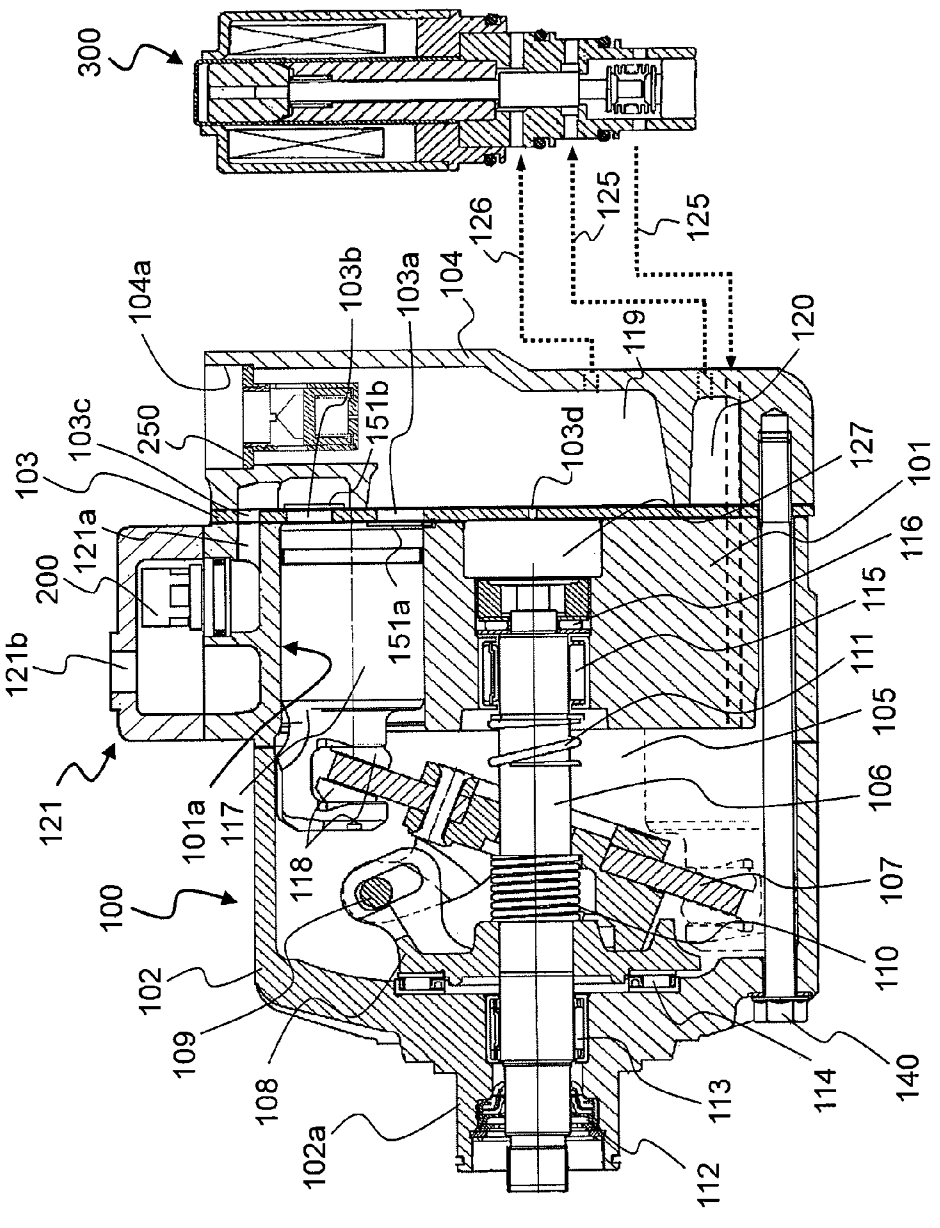

300
126
125
125
104a
103b
103a
104
119
120
103c
250
151b
103d
103
121a
127
101
200
116
121b
151a
115
111
105
121
101a
117
106
118
100
107
110
102
109
108
113
114
140
102a
112

FIG. 1

FIG. 2A

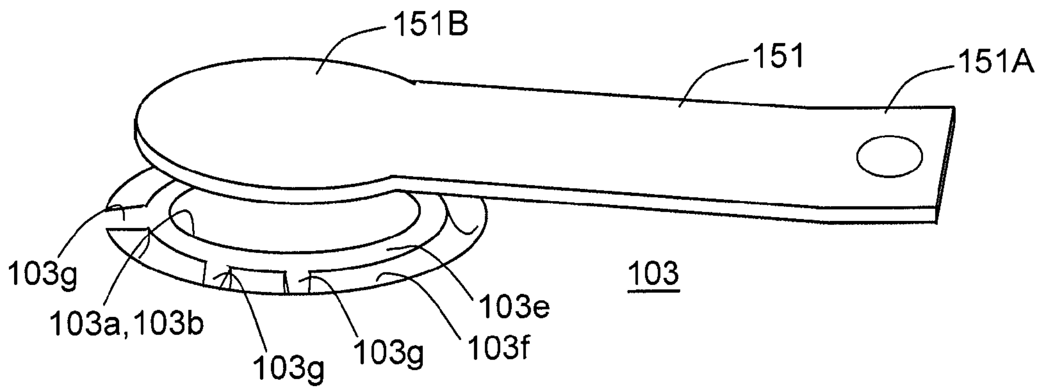

151B
151
151A
103g
103a,103b
103g
103g
103f
103e
103

FIG. 2B

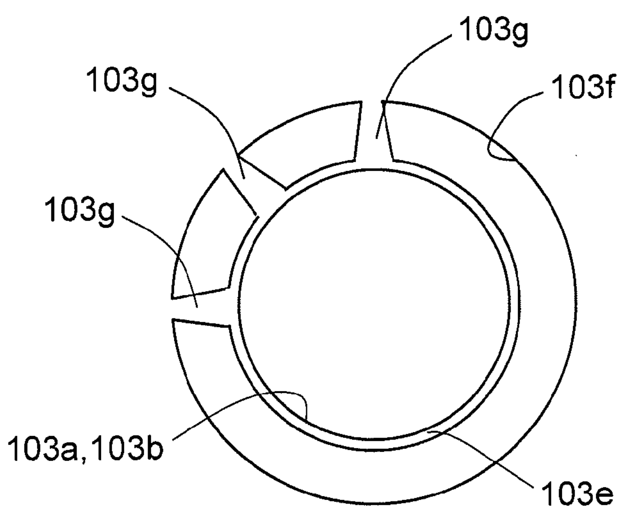

103g
103f
103g
103g
103a,103b
103e

FIG. 3

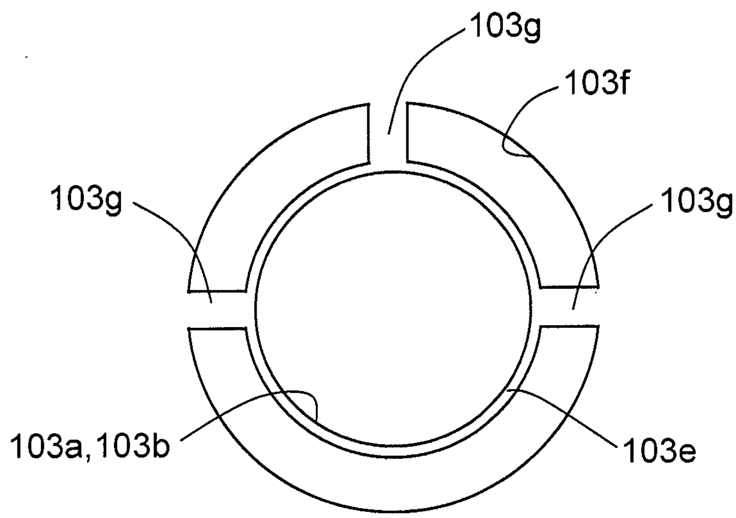


FIG. 4

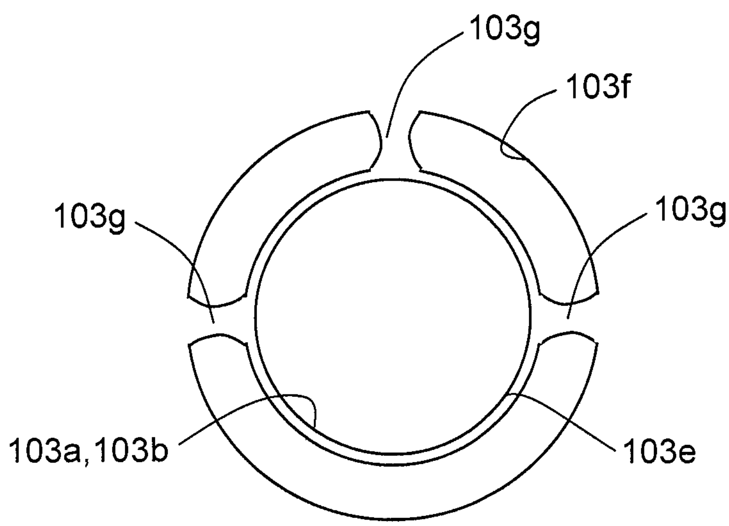


FIG. 5

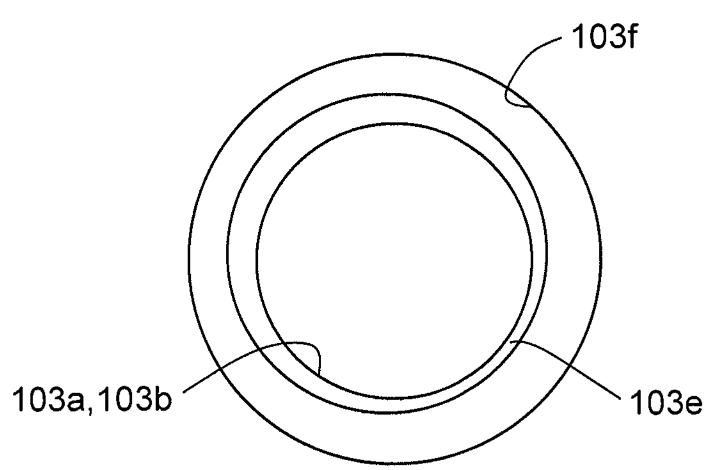


FIG. 6A

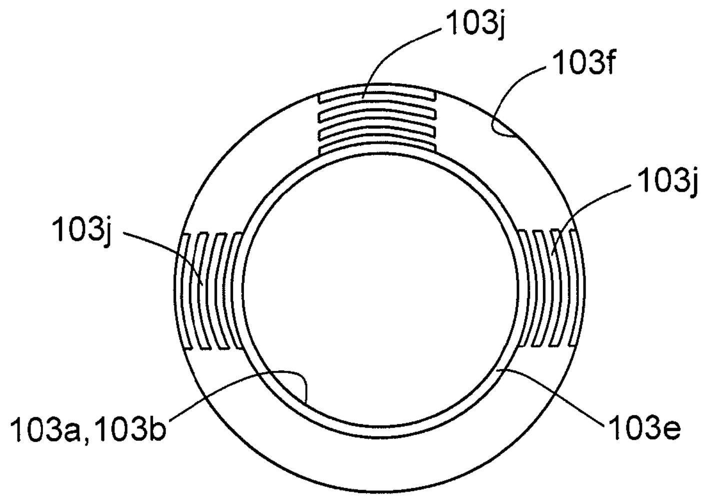


FIG. 6B

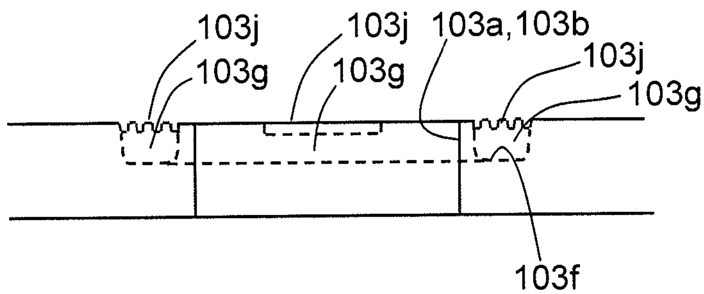


FIG. 7

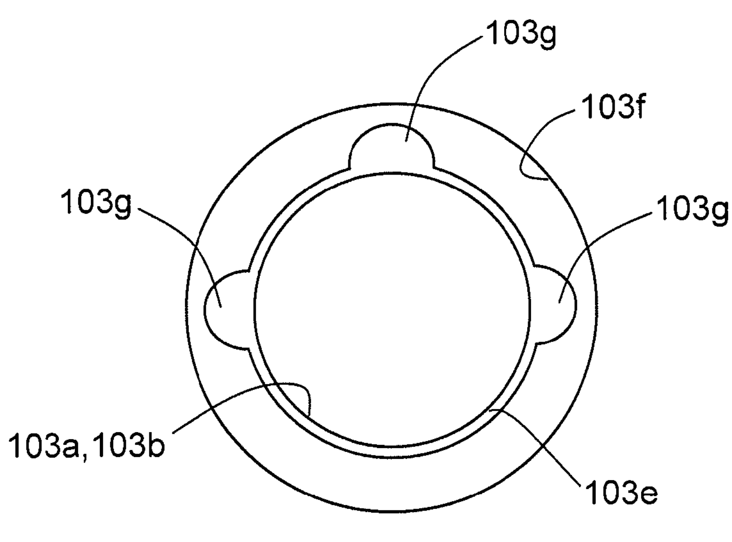


FIG. 8

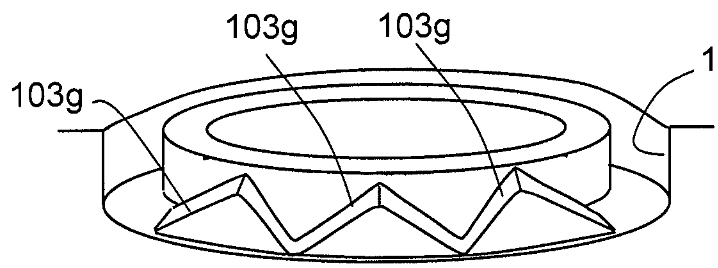


FIG. 9

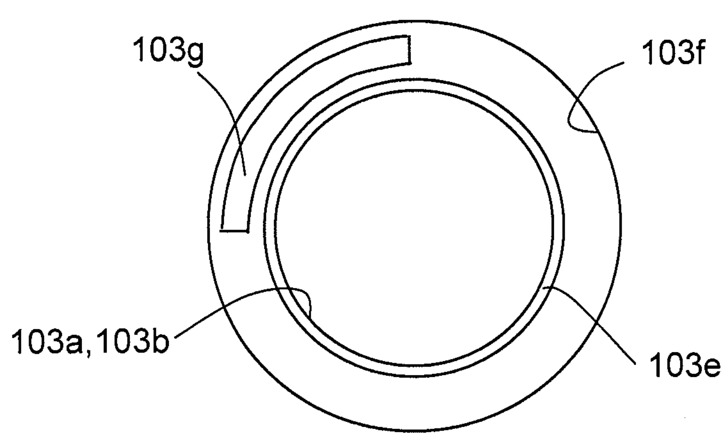


FIG. 10A

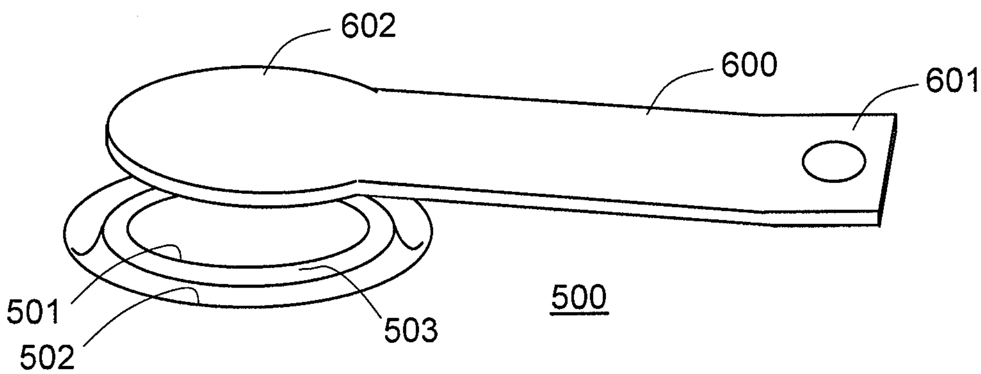


FIG. 10B

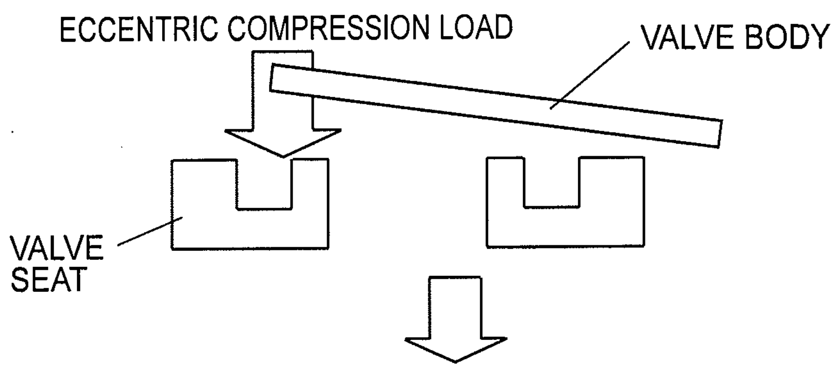


FIG. 10C

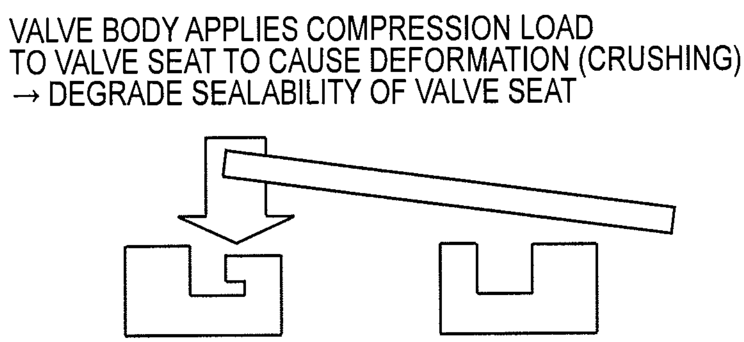


FIG. 10D

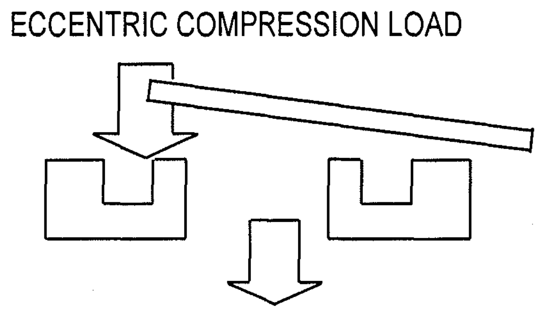


FIG. 10E

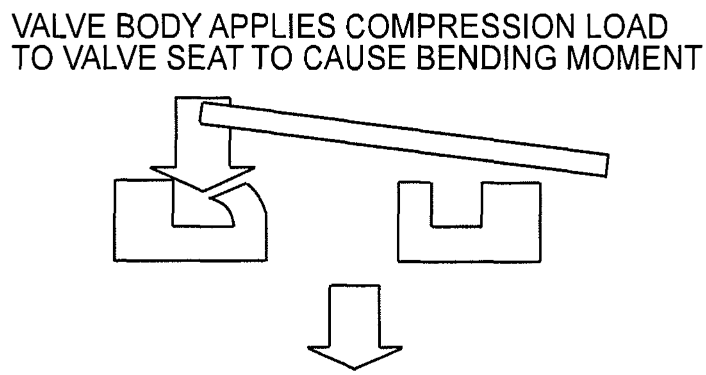


FIG. 10F

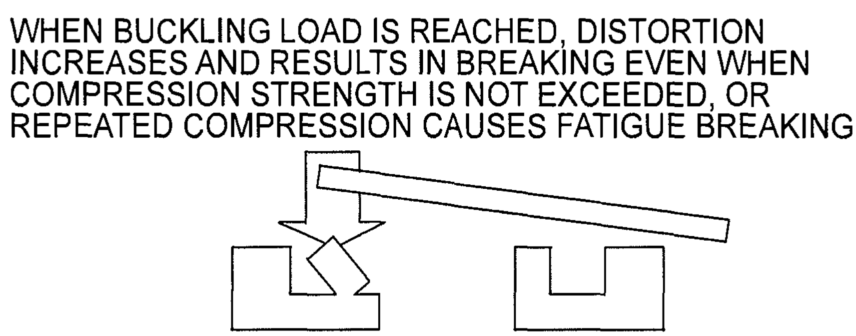
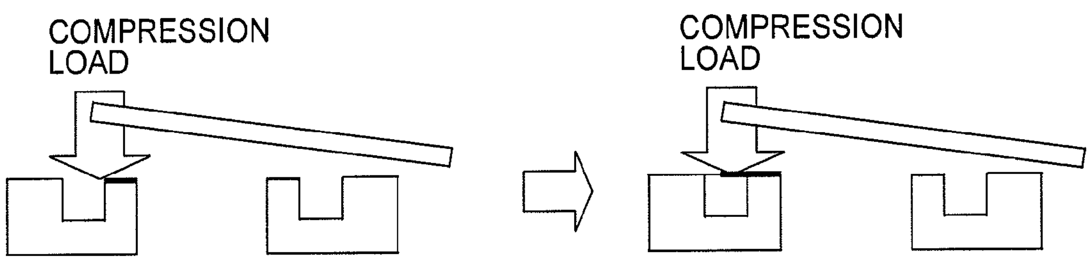


FIG. 11



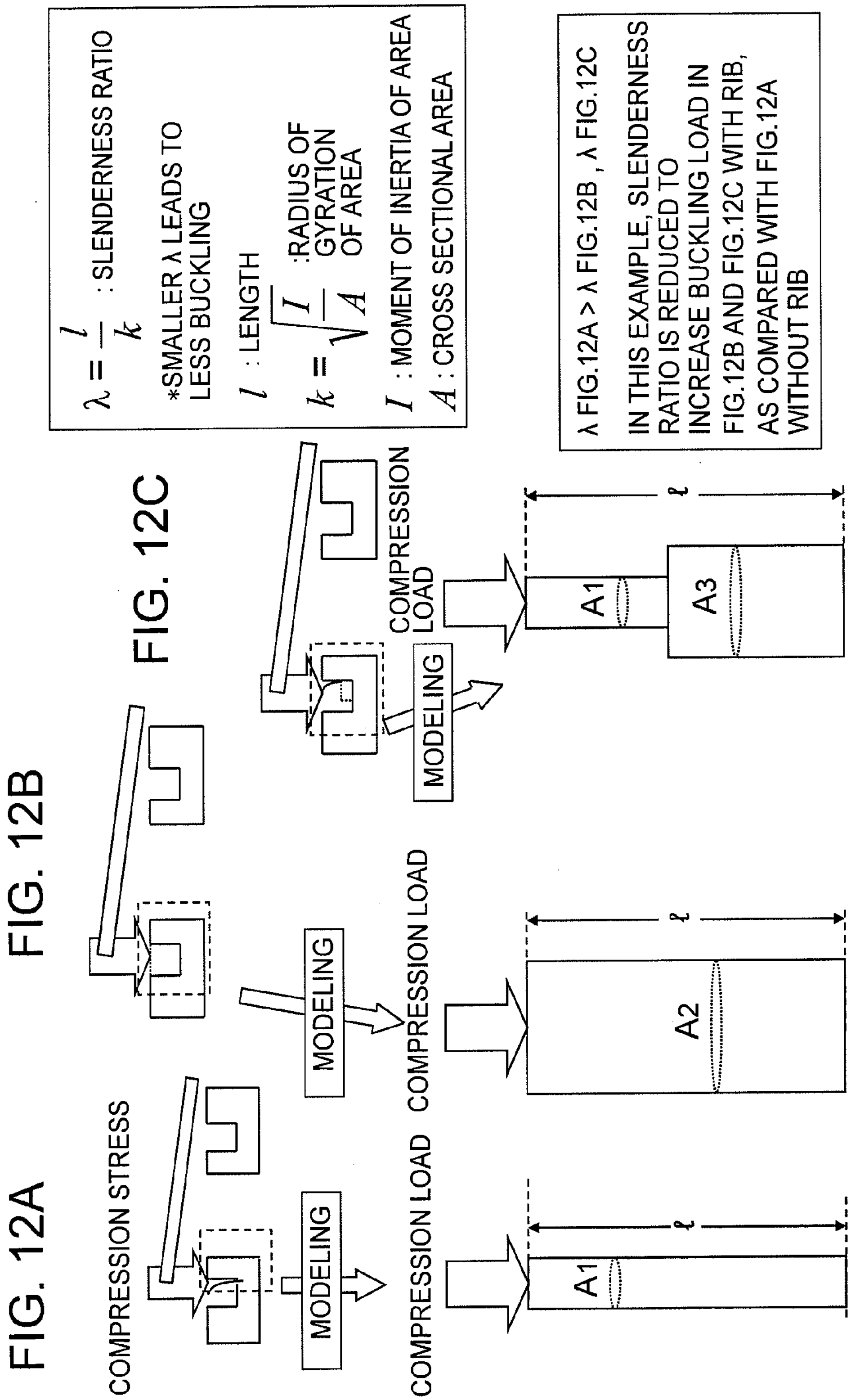
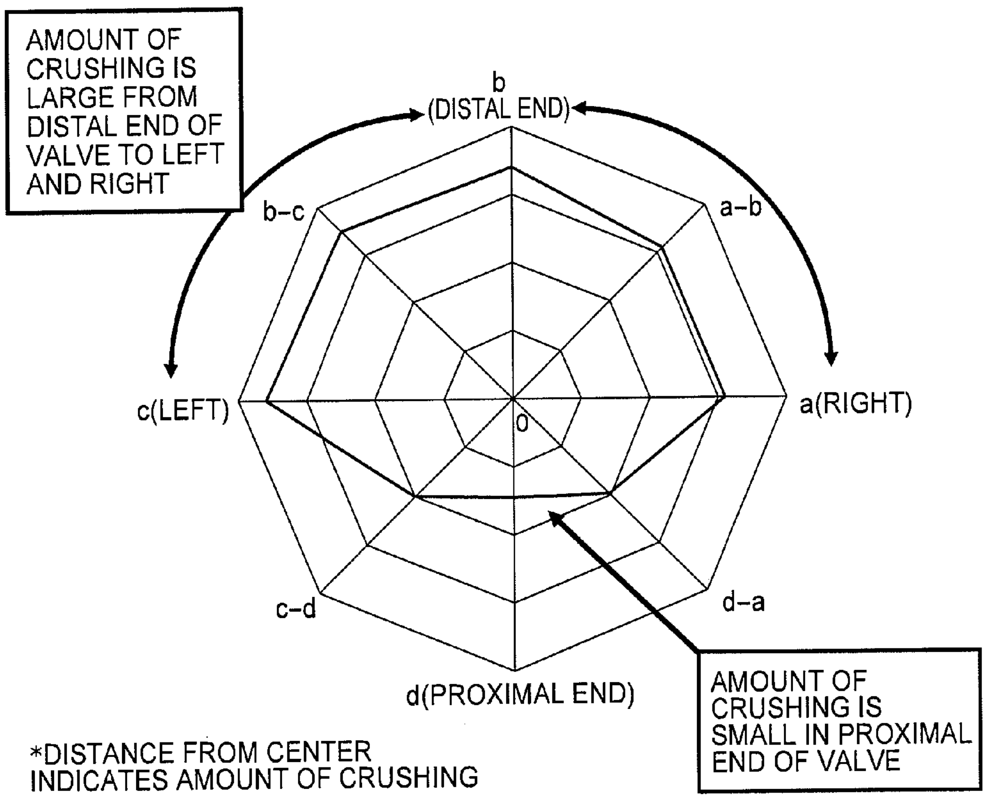


FIG. 12A
COMPRESSION STRESS
MODELING
COMPRESSION LOAD
A1
ℓ
FIG. 12B
MODELING
COMPRESSION LOAD
A2
ℓ
FIG. 12C
MODELING
COMPRESSION LOAD
A1
A3
ℓ
$\lambda = \frac{l}{k}$: SLENDERNESS RATIO
*SMALLER λ LEADS TO LESS BUCKLING
l : LENGTH
$k = \sqrt{\frac{I}{A}}$:RADIUS OF GYRATION OF AREA
I : MOMENT OF INERTIA OF AREA
A : CROSS SECTIONAL AREA
λ FIG.12A > λ FIG.12B , λ FIG.12C
IN THIS EXAMPLE, SLENDERNESS RATIO IS REDUCED TO INCREASE BUCKLING LOAD IN FIG.12B AND FIG.12C WITH RIB, AS COMPARED WITH FIG.12A WITHOUT RIB

FIG. 13


AMOUNT OF CRUSHING IS LARGE FROM DISTAL END OF VALVE TO LEFT AND RIGHT
b (DISTAL END)
a-b
b-c
a(RIGHT)
c(LEFT)
0
c-d
d-a
d(PROXIMAL END)
AMOUNT OF CRUSHING IS SMALL IN PROXIMAL END OF VALVE
*DISTANCE FROM CENTER INDICATES AMOUNT OF CRUSHING

VALVE DEVICE FOR COMPRESSOR

RELATED APPLICATIONS

This is a U.S. national stage of International application No. PCT/JP2012/053042 filed on Feb. 10, 2012.

This application claims the priority of Japanese application no. 2011-050717 filed Mar. 8, 2011, the entire content of which is hereby incorporated by reference.

FIELD OF THE INVENTION

Technical Field

The present invention relates to a valve device opened and closed to draw or discharge a refrigerant in a compressor used in a refrigeration cycle air conditioner and the like.

BACKGROUND ART

In this type of compressor, as disclosed in, for example, Patent Document 1, a suction hole for drawing a refrigerant from a suction chamber into a cylinder bore and a discharge hole for discharging a compressed refrigerant from the cylinder bore into a discharge chamber are formed in a valve plate placed between a cylinder head and the cylinder bore, and a suction valve and a discharge valve of a reed valve structure for opening and closing the suction hole and the discharge hole are attached to the valve plate.

A valve seat is formed in an outer peripheral portion of each of the suction hole and the discharge hole, so as to protrude in a boss shape to a groove formed around the outside thereof.

CITATION LIST

Patent Document

Patent Document 1: Japanese Laid-Open Patent Application Publication No. H11-210626

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

Here, oil mixed into the refrigerant adheres between a valve body and a seat surface of the valve seat and causes the valve body to adhere to the seat surface, making valve opening difficult. In the case in which the radial width (hereafter simply referred to as "width") of the valve seat is large and the seat area is large, the valve body adheres to the seat surface with a large force. When, upon valve opening, a negative suction pressure or a discharge pressure from the cylinder bore increases and reaches the adhesion force (valve opening pressure) or more, the valve opens at once. Pressure pulsations (suction pulsations or discharge pulsations) occurring at this time cause an increase in noise and a decrease in compressor efficiency.

If the width of the valve body seat surface is reduced to make the seat area smaller in order to solve the abovementioned problem, before the noise and the efficiency decrease due to pressure pulsations are sufficiently suppressed, the impact upon seating the valve body on the valve seat causes damage, such as crushing, buckling, and fatigue, of the valve seat from a seat portion on the valve body distal side in which the impact is significant. Resulting lower sealability accelerates degradation in compressor performance.

In view of these conventional problems, the present invention has an object of providing a valve device for a compressor, the valve device being capable of preventing the adhesion of the valve body to the seat surface to suppress noise and maintain preferable compressor efficiency and also ensuring durability to prevent degradation in compressor performance.

Means for Solving the Problems

Therefore, the present invention provides a valve device having a reed valve structure, and the valve device includes: a valve plate in which a valve hole opened and closed to draw or discharge a refrigerant is formed; a valve seat formed in an outer peripheral portion of the valve hole in the valve plate so as to protrude in a boss shape to a groove formed around an outside thereof; and a valve body having a proximal end connected to the valve plate and a distal end allowed to freely come into and out of contact with a seat surface of the valve seat, in which the valve seat or a peripheral portion including the valve seat is shaped so that a portion corresponding to a distal side of the valve body is reinforced relative to a portion corresponding to a proximal side of the valve body.

Advantageous Effect of the Invention

In the valve device of the reed valve structure, the portion of the valve seat on which the distal side of the valve body is seated has, for example, a large amount of stroke upon valve opening and closing as compared with the portion on which the proximal side of the valve body is seated. Accordingly, due to the impact upon seating the valve body, a large compression load acts on the portion of the valve seat on which the distal side of the valve body is seated.

Hence, by employing such a shape that makes the portion of the valve seat on which the distal side of the valve body is seated, where a large compression load acts, stronger than the portion on which the proximal, side of the valve body is seated, where a relatively small compression load acts, in the valve seat, crushing, buckling, and fatigue are suppressed. Degradation in compressor performance caused by lower sealability can be suppressed in this way.

Moreover, this partial reinforcement structure enables the seat area to be reduced to such an extent that ensures a necessary strength, at least in the portion on which the distal side of the valve body is seated where a relatively small load acts. This reduces the adhesion force of the valve body to the seat surface and suppresses the occurrence of pressure pulsations upon valve opening, so that noise can be suppressed and preferable compressor efficiency can be maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a longitudinal sectional view illustrating a variable capacity compressor including a valve device according to the present invention.

FIG. **2** is a perspective view and a plan view illustrating a valve device according to a first embodiment.

FIG. **3** is a plan view illustrating a valve device according to a second embodiment.

FIG. **4** is a plan view illustrating a valve device according to a third embodiment.

FIG. **5** is a plan view illustrating a valve device according to a fourth embodiment.

FIG. **6** is a plan view and a longitudinal sectional view illustrating a valve device according to a fifth embodiment.

FIG. **7** is a plan view illustrating a valve device according to a sixth embodiment.

FIG. **8** is a partial perspective and broken view illustrating a valve device according to a seventh embodiment.

FIG. **9** is a plan view illustrating a valve device according to an eighth embodiment.

FIG. **10** is a view for explaining a problem with a conventional valve device.

FIG. **11** is a view for explaining a crushing suppression effect of a valve device according to the present invention.

FIG. **12** is a view for explaining a buckling and fatigue suppression effect of a valve device according to the present invention.

FIG. **13** is a view illustrating a distribution of crushing amounts of a valve seat in a conventional valve device.

MODE FOR CARRYING OUT THE INVENTION

Hereunder, an embodiment of the present invention will be explained in detail, based on the attached drawings.

FIG. **1** illustrates a compressor in the embodiments. The compressor is a swash plate-type variable capacity reciprocating compressor **100** used in an air conditioning system of a vehicle.

The compressor **100** includes: a cylinder block **101**; a front housing **102** connected to one end of the cylinder block **101**; and a cylinder head **104** connected to the other end of the cylinder block **101** via a valve plate **103**.

The cylinder block **101** and the front housing **102** define a crank chamber **105**. A drive shaft **106** is provided so as to extend laterally across the a crank chamber **105**, and the drive shaft **106** is rotatably supported via bearings **113**, **115**, and **116** in the radial and thrust directions with respect to the cylinder block **101** and the front housing **102**.

The tip of the drive shaft **106** passes through a boss portion **102***a* of the front housing **102** and protrudes out of the front housing **102**. Drive sources such as an engine and a motor of a vehicle are connected to the protruding tip via a power transmission device.

A shaft seal device **112** is provided between the drive shaft **106** and the boss portion **102***a*, to block the inside (the crank chamber **105**) of the front housing **102** from outside.

In the crank chamber **105**, a rotor **108** is fixed to the drive shaft **106**, and a swash plate **107** is attached to the rotor **108** via a connection portion **109**.

The drive shaft **106** passes through a through hole formed in a center portion of the swash plate **107**. The swash plate **107** rotates together with the drive shaft **106**, and is slidably and inclinably supported in the axial direction of the drive shaft **106**. The rotor **108** is rotatably supported by a thrust bearing **114** disposed on the inner wall of the front end of the front housing **102**.

A coil spring **110** for biasing the swash plate **107** in the direction in which the angle of inclination of the swash plate **107** decreases is disposed between the rotor **108** and the swash plate **107**, and a coil spring **111** for biasing the swash plate **107** in the direction in which the angle of inclination of the swash plate **107** increases is disposed between the cylinder block **101** and the swash plate **107**.

In the cylinder block **101**, a plurality of cylinder bores **101***a* are formed so as to surround the drive shaft **106**. In each cylinder bore **101***a*, a piston **117** is housed in a state of being allowed to reciprocate in the axial direction of the drive shaft **106**. Each piston **117** engages with an outer peripheral portion of the swash plate **107** via a shoe **118** and, when the swash plate **107** rotates together with the drive shaft **106**, each piston **117** reciprocates in the cylinder bore **101***a*.

In the cylinder head **104**, a suction chamber **119** is disposed on an extension of the axis of the drive shaft **106**, and a discharge chamber **120** is disposed to annularly surround the suction chamber **119**. The suction chamber **119** communicates with the cylinder bore **101***a* via a valve hole **103***a* formed in the valve plate **103** and a valve body **151***a* of a suction valve. The discharge chamber **120** communicates with the cylinder bore **101***a* via a valve body **151***b* of a discharge valve and a valve hole **103***b* formed in the valve plate **103**.

The front housing **102**, the cylinder block **101**, the valve plate **103**, and the cylinder head **104** are fastened together by a plurality of through bolts **140** via gaskets not illustrated, to form a compressor housing.

A muffler **121** is provided outside the cylinder block **101**. In the muffler **121**, a communication path **121***a* communicating with the discharge chamber **120** is formed to overlap with a communication path **103***c* formed in the valve plate, and a check valve **200** is arranged. The check valve **200** opens only when the pressure in the discharge chamber **120** on the upstream side is higher than the pressure on the downstream side by a predetermined value or more, to cause a refrigerant flowing in from the discharge chamber **120** via the communication paths **103***c* and **121***a* to be discharged from a discharge port **121***b*.

In the cylinder head **104**, a suction port **104***a* connected to a suction-side refrigerant circuit (evaporator) of the air conditioning system of the vehicle is formed, and an opening adjustment valve **250** is placed near the downstream side of the suction port **104***a*. The flow-controlled refrigerant is drawn into the suction chamber **119** from the suction-side refrigerant circuit (evaporator) via the suction port **104***a* and the opening adjustment valve **250**.

A capacity control valve **300** is attached to the cylinder head **104**.

The capacity control valve **300** adjusts an opening of a communication path **125** communicating between the discharge chamber **120** and the crank chamber **105**, to control the inflow amount of discharge refrigerant that flows into the crank chamber **105**.

The refrigerant in the crank chamber **105** passes through the gap between the drive shaft **106** and the bearings **115** and **116**, and flows into the suction chamber **119** via a space **127** formed in the cylinder block **101** and an orifice **103***d* formed in the valve plate **103**.

Thus, the capacity control valve **300** adjusts the inflow amount of discharge refrigerant that flows into the crank chamber **105** and changes the pressure in the crank chamber **105**, thereby changing the angle of inclination of the swash plate **107**, i.e. the amount of stroke of the piston **117**. This enables the discharge capacity of the compressor **100** to be controlled.

Here, the capacity control valve **300** adjusts the amount of current to an internal solenoid based on an external signal, to control the discharge capacity of the compressor **100** so that the pressure of the suction chamber **119** introduced into a pressure sensitive chamber in the capacity control valve **300** via a communication path **126** is at a predetermined value. The capacity control valve **300** also interrupts the current to the internal solenoid, to forcibly open the communication path **125** and control the discharge capacity of the compressor **100** to the minimum.

A valve device including the valve body **151** a and the valve hole **103***a* of the suction valve, and the valve body **151***b* and the valve hole **103***b* of the discharge valve is described in detail below.

First, a basic structure (conventional structure) of this type of valve device and the influence exerted on the valve seat by the compression load that acts on the seat surface of the valve seat upon opening and closing of the valve body are described.

As illustrated in FIG. **10**A, in an outer peripheral portion of a valve hole **501** formed in a valve plate **500**, a valve seat **503** is formed so as to protrude in a boss shape to a groove **502** formed around the outside thereof. By providing the groove **502** to form the boss-shaped valve seat **503**, it is possible to accurately form a seat surface for a valve body **600**. In addition, by pressing the valve plate **500**, it is possible to easily form the valve seat **503** simultaneously with the groove **502**.

The valve body **600** configured by a long thin reed valve has a proximal end **601** fixed to the valve plate, and a circular distal end **602** coming into and out of contact with the top surface (seat surface) of the valve seat **503** to close and open the valve hole **501**.

As mentioned above, the portion of the valve seat **503** on which the distal side of the valve body **600** is seated has, for example, a large amount of stroke upon valve opening and closing as compared with the portion on which the proximal side of the valve body **600** is seated, so that a large compression load acts on the portion of the valve seat **503** on which the distal side of the valve body **600** is seated due to the impact upon seating the valve body **600**.

If the radial width of the valve seat **503** is reduced to reduce the adhesion force of the valve body **600** to the valve seat **503**, before the noise and the efficiency decrease due to pressure pulsations are sufficiently suppressed, the above-mentioned compression load causes damage from the portion on which the distal side of the valve body **600** is seated, due to insufficient strength of the portion.

As illustrated in FIGS. **10**B and **10**C, One form of damage is "crushing" caused in a manner that, when a large compression load acts on the seat surface due to the impact upon seating on the valve seat, a large surface pressure (pressure per unit area) is generated and induces a plastic deformation.

As illustrated in FIGS. **10**D, **10**E, and **10**F, another form of damage is "buckling" caused in a manner that when a compression load acts on the seat surface of the valve seat, a bending moment is generated and reaches a buckling load. There is also "fatigue" caused by repeated generation of the bending moment even in the case in which the buckling load is not reached.

Thus, in the following embodiments, the valve seat or the peripheral portion including the valve seat is shaped so that the portion corresponding to the distal side of the valve body is reinforced more than the portion corresponding to the proximal side of the valve body, in order to prevent damage such as "crushing", "buckling", and "fatigue" mentioned above.

In an embodiment illustrated in FIGS. **2**A and **2**B, a plurality of (three in FIGS. **2**A and **2**B) ribs **103***g* extend radially from the peripheral wall of the portion of a valve seat **103***e* on which the distal side of a valve body **151** is seated, to the outer peripheral wall of a groove **103***f*.

The shape of the rib **103***g* may be any shape, such as a radially outwardly tapered shape as illustrated in FIGS. **2**A and **2**B, a shape with a uniform radial width as illustrated in FIG. **3**, or a shape narrower in a radial center portion as illustrated in FIG. **4**.

The height (the height from the bottom of the groove **103***f*, the same applies hereafter) of the rib **103***g* is set to be equal to or slightly less than the height of the seat surface (which is the valve plate surface) of the valve seat **103***e*.

The following describes the effects of these embodiments of the valve device.

The case in which the height of the rib **103***g* is set to be equal to the height of the seat surface (which is the valve plate surface) of the valve seat **103***e* is described first.

In this case, the peripheral portion of the valve body **151** (**151***a* or **151***b*) on the distal side is seated not only on the seat surface of the valve seat **103***e* but also on the flat top surface of each rib **103***g*. This increases the area of the seat surface including the portions in which these ribs **103***g* are formed and their nearby valve seat **103***e*. Therefore, even when a large compression load is applied due to the impact upon seating the distal side of the valve body **151**, crushing can be effectively suppressed as a result of a reduction in surface pressure (see an explanatory view of FIG. **11**).

In addition, the cross sectional area (the sectional area in the direction parallel to the valve plate, the same applies hereafter) of the portion in which the rib **103***g* and the valve seat **103***e* are integrated is increased to reduce the slenderness ratio λ, thus increasing the buckling load in the portion. Therefore, even when a large compression load is applied due to the impact upon seating the distal side of the valve body **151**, buckling can be effectively suppressed and also fatigue due to a repetitive compression load can be effectively suppressed (see an explanatory view of FIG. **12**B).

By suppressing the damage of the valve seat **103***e* such as crushing, buckling, and fatigue in this way, degradation in compressor performance caused by lower sealability can be prevented.

As a result of enhancing the effect of suppressing crushing, buckling, and fatigue by the partial reinforcement of the valve seat **103***e*, the width of the valve seat **103***e* on the whole circumference can be reduced to make the total area of the seat surface smaller. This reduces the adhesion force of the valve body **151** due to oil inserted between the valve body **151** and the seat surface of the valve seat **103***e* and sufficiently suppresses the occurrence of pressure pulsations upon valve opening, so that noise can be suppressed and preferable compressor efficiency can be maintained.

In FIGS. **2**A and **2**B, the rib **103***g* is disposed at each of: one position in the portion of the valve seat **103***e* on which the distal end of the valve body **151** is seated; and two positions in the portion on the left side of the foregoing position, as illustrated in FIG. **2**B.

The abovementioned arrangement of the ribs **103***g* is achieved in response to the result of measuring the amount of crushing of an annular valve seat in the case in which no rib is provided as illustrated in FIG. **13**. The amount of crushing of the portion on which the distal side of the valve body is seated is larger on the left side of the direction from the proximal end to the distal end of the valve body in FIG. **13**, suggesting that a large compression load acts on the left side. For example, in the case in which the center axis of the cylinder bore **101***a* is located on the left side of the direction from the proximal end **151**A to the distal end **151**B of the valve body **151** in FIG. **13**, typically the suction force from the cylinder bore is larger on the left side and causes a large compression load to act on the seat surface of the valve seat on the left side.

Meanwhile, as illustrated in FIG. **13**, the amount of crushing is especially large within the range of 90 degrees on each side of the direction from the center of the valve seat **103***e* to the distal end of the valve body, as compared with the range exceeding 90 degrees on each side. It is therefore clear that the rib **103***g* is preferably disposed within the range of 90 degrees on each side. Accordingly, in FIGS. **3** and **4**, the rib **103***g* is disposed at each of: one position in the direction from the center of the valve seat **103***e* to the distal end of the valve body **151**; and two positions of 90 degrees on both sides of the direction to the distal end of the valve body **151**. Note that, though the positions of 90 degrees on both sides of the direction to the distal end of the valve body **151** are midway between the portion of the valve seat **103**e on the distal side of the valve body **151** and the portion of the valve seat **103**e on the proximal side of the valve body **151**, the rib **103**g at the position in the direction to the distal end of the valve body **151** and the ribs **103**g at the positions of 90 degrees on both sides are combined, so that the valve seat **103**e or the peripheral portion including the valve seat **103**e on the distal side of the valve body **151** is reinforced more than on the proximal side of the valve body **151**.

Three ribs **103**g are provided in the embodiments described above; however, two ribs or four or more ribs may be provided. Moreover, the ribs **103**g adjacent in the circumferential direction may be equally spaced or unequally spaced.

Furthermore, the rib **103**g may be provided only at one position. On the basis of the result indicated in FIG. **13**, one rib **103**g is preferably disposed in the range of about 45 degrees on the side where the amount of crushing is larger (the left side in FIG. **13**), in the direction from the center of the valve seat **103**e to the distal end of the valve body.

The above-mentioned rib arrangement positions and number of ribs arranged also apply to the following embodiments.

The case in which the height of the rib **103**g is set to be slightly less than the height of the seat surface (which is the valve plate surface) of the valve seat **103**e in the embodiments illustrated in FIGS. **2** to **4** is described below.

In this case, the long thin portion of the valve seat **103**e that is provided with the rib **103**g and is higher than the top surface of the rib **103**g is made sufficiently small to reduce the slenderness ratio λ, thus increasing the buckling load. Therefore, even when a large compression load is applied due to the impact upon seating the distal side of the valve body **151**, buckling can be effectively suppressed and also fatigue due to a repetitive compression load can be effectively suppressed (see an explanatory view of FIG. **12**C). Degradation in compressor performance caused by lower sealability can be prevented in this way.

Moreover, since the valve body **151** is not seated on the rib **103**g, the total area of the seated valve body **151** is reduced to reduce the adhesion force. This further enhances the noise suppression effect and the compressor efficiency maintenance effect.

In the case in which the valve seat on the proximal side of the valve body is reinforced in the same way as the valve seat on the distal side of the valve body by providing a rib and the like, the seat portion on the distal side that is subject to a large compression load is relatively low in durability strength as compared with the seat portion on the proximal side, and thus, it is easy to damage from this weak portion. Hence, in the present invention, the seat portion on the distal side that is subject to a large compression load is reinforced more than the seat portion on the proximal side to thereby make the durability strength of the entire valve seat uniform, so that crushing, buckling, and fatigue can be effectively suppressed.

FIG. **5** illustrates an embodiment in which with respect to the center axis of the valve hole **103**a or **103**b forming the inner peripheral surface of the valve seat **103**e, the center axis of the outer peripheral surface of the valve seat **103**e is offset toward the distal side of the valve body **151**, the valve seat **103**e is formed so that the radial thickness of the portion on which the distal side of the valve body **151** is seated is greater than the radial thickness of the portion on which the proximal side of the valve body **151** is seated. In this embodiment, based on the result in FIG. **13**, the center axis of the outer peripheral surface of the valve seat **103**e is offset in the direction of about 45 degrees on the side where the amount of crushing is large (the left side in FIG. **13**) in the direction from the center of the valve seat to the distal end of the valve body.

In this embodiment, by increasing the seat area of the portion of the valve seat **103**e on which the distal side of the valve body **151** is seated, the surface pressure is reduced. Thus, crushing can be suppressed. In addition, the cross sectional area of the same portion is increased, so that buckling and fatigue can be suppressed. Degradation in compressor performance can be prevented in this way.

Furthermore, the width of the portion of the valve seat **103**e on which the proximal side of the valve body **151** is seated is reduced to make the total area of the seated valve body **151** smaller. This reduces the adhesion force, so that noise can be suppressed and preferable compressor efficiency can be maintained.

FIG. **6** illustrates an embodiment in which a plurality of ribs **103**g extend radially from the peripheral wall of the portion of the valve seat **103**e on which the distal side of the valve body **151** is seated to the outer peripheral wall of the groove **103**f, and also the top surface of the rib **103**g has a plurality of parallel ridges **103**j along the circumferential direction.

The height of the ridge **103**j of the rib **103**g is set to be equal to the height of the seat surface (which is the valve plate surface) of the valve seat, as illustrated in FIG. **6**.

According to this structure, the valve body **151** is also seated on each ridge **103**j of the rib **103**g, so that the surface pressure is reduced. Thus, crushing can be suppressed.

Moreover, the rib **103**g formed integrally with the valve seat **103**e increases the cross sectional area of the portion to reduce the slenderness ratio λ, so that buckling and fatigue can be suppressed.

Degradation in compressor performance can be prevented in this way.

Especially in this embodiment, the buckling and fatigue suppression effects can be further enhanced by ensuring a sufficiently large cross sectional area of the rib **103**g, while limiting the seat area increase to a minimum necessary level effective for crushing suppression by providing the ridge **103**j on the top surface of the rib **103**g instead of making the top surface flat.

FIG. **7** illustrates an embodiment in which the radial tip of each rib **103**g extending radially from the peripheral wall of the portion of the valve seat **103**e on which the distal side of the valve body **151** is seated does not reach the outer peripheral wall of the groove **103**f.

In this case, the rib **103**g has the same effects as in the embodiments illustrated in FIGS. **2** to **4**, for each of the embodiments that the top surface of the rib **103**g is equal in height to the seat surface (which is the valve plate surface) of the valve seat and that the top surface of the rib **103**g is slightly less in height than the seat surface of the valve seat. In the equal height embodiment, crushing, buckling, and fatigue are suppressed. In the slightly less height embodiment, buckling and fatigue are suppressed to prevent degradation in compressor performance, and also the adhesion force is reduced to suppress noise and maintain preferable compressor efficiency.

FIG. **8** illustrates an embodiment in which each tapered rib **103**g tapered from the bottom surface of the groove **103**f toward the top in the portion of the valve seat **103**e on which the distal side of the valve body **151** is seated is disposed.

In this embodiment, if the top of the rib **103**g is equal in height to the seat surface of the valve seat **103**e, the compression load from the valve body **151** is supported by the valve seat **103**e and the rib **103**g, so that crushing of the valve seat

103*e* can be suppressed. In such a case, similar to the embodiment illustrated in FIG. **6**, crushing can be suppressed while limiting the seat area increase to a minimum necessary level effective for crushing suppression.

Moreover, by providing the rib **103***g* integrally with the valve seat **103***e*, the slenderness ratio λ of the portion where the rib **103***g* is provided is reduced to suppress buckling and fatigue.

Degradation in compressor performance can be prevented in this way.

FIG. **9** illustrates an embodiment in which a rib **103***g* raised from the bottom surface of the groove **103***f* in the portion of the valve seat **103***e* on which the distal side of the valve body **151** is seated is formed separately from the valve seat **103***e*. The height of the rib **103***g* is assumed to be equal to the height of the seat surface (which is the valve plate surface) of the valve seat **103***e*.

In the case in which the rib **103***g* is formed separately from the valve seat **103***e* as in this embodiment, the valve body **151** is also seated on the rib **103***g* to reduce the surface pressure of the valve seat **103***e*, so that crushing of the valve seat **103***e* can be suppressed.

In this embodiment, the valve seat **103***e* itself is not directly reinforced, as the rib **103***g* is separate from the valve seat **103***e*. However, the reduction in surface pressure contributes to a smaller compression load on the portion of the valve seat **103***e* on which the distal side of the valve body **151** is seated. Thus, bending moment generated in the valve seat **103***e* is reduced, so that buckling and fatigue can be suppressed as well.

Degradation in compressor performance can be prevented in this way.

Furthermore, the partial rib **103***g* is formed to reduce the total area of the valve body seat surface. Thus, the adhesion force is reduced, so that noise can be suppressed and preferable compressor efficiency can be maintained.

Though the abovementioned embodiments are preferably applied to both the suction valve device and the discharge valve device, it is obvious that certain advantageous effects can be achieved even in the case in which the abovementioned embodiments are applied to only one of the suction valve device and the discharge valve device.

Though the abovementioned embodiments are applied to a piston reciprocating compressor, the present invention is applicable to all types of compressors, such as a scroll compressor, that use a reed valve opened and closed to draw or discharge a refrigerant.

DESCRIPTION OF REFERENCE NUMERALS

100 compressor
101 cylinder block
101*a* cylinder bore
103 valve plate
103*a* valve hole (suction side)
103*b* valve hole (discharge side)
103*e* valve seat
103*f* groove
103*g* rib
104 cylinder head
151 valve body
151*a* valve body of suction valve
151*b* valve body of discharge valve
151A proximal end
151B distal end

The invention claimed is:

1. A valve device for a compressor, which has a reed valve structure, comprising:

a valve plate in which a valve hole opened and closed to draw or discharge a refrigerant is formed;

a valve seat formed in an annular shape in an outer peripheral portion of the valve hole in the valve plate, wherein a groove is formed around an outside of the valve seat; and

a valve body having a proximal end connected to the valve plate and a distal end allowed to freely come into and out of contact with a seat surface of the valve seat,

wherein at least one rib extends radially outwardly from the portion of the valve seat corresponding to the distal side of the valve body, and

wherein a height of the at least one rib from a bottom of the groove is less than a height of the seat surface of the valve seat from the bottom of the groove.

2. The valve device for the compressor according to claim **1**, wherein the at least one rib extends from an outer peripheral wall of the valve seat to an outer peripheral wall of the groove.

3. The valve device for the compressor according to claim **1**, wherein the at least one rib extends from an outer peripheral wall of the valve seat to a point between the outer peripheral wall of the valve seat and an outer peripheral wall of the groove.

4. The valve device for the compressor according to claim **1**, wherein the at least one rib is tapered from the bottom of the groove toward an opening of the groove.

5. The valve device for the compressor according to claim **1** wherein the at least one rib is provided in a center angle range of 90 degrees on each side of a direction from a center of the valve hole to the distal end of the valve body.

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